RUCTION MANUAL

TYPE 1557-A

VIBRATION CALIBRATOR

GENERAL RADIO COMPANY

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INSTRUCTION MANUAL

TYPE 1557-A

VIBRATION CALIBRATOR

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West Concord, Massachusetts, USA

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

Figure 1. Type 1557-A Vibration Calibrator.

SPECIFICATIONS

OUTPUT

Acceleration: 1 g, rms, ±10%.
Velocity: 0.614 in/s (15.6 mm/s), rms.
Displacement: 0.000978 in (0.0248 mm), rms; 0.00277 in (0.0704 mm), peak-to-peak.
Frequency: 100 c/s ±1% for 50-gram load; 100 c/s +0, −2% for 300-gram load.

GENERAL

Batteries: Four RM-4 (or equivalent) mercury cells. Battery life is 100 hours of continuous operation. (Dry cells optional; please specify.)
Accessory Supplied: Leather carrying case.
Dimensions: 4 by 8 by 4 in. (105 by 205 by 105 mm).
Weight: 3¼ lb (1.5 kg).

General Radio Experimenter reference: Vol. Nos. 11 & 12, November-December, 1960.

Section 1

INTRODUCTION

1.1 PURPOSE.

The Type 1557-A Vibration Calibrator (Figure 1) can be used to check the calibration of vibration pickups (accelerometers), vibration meters, and other vibration-measuring systems that use small crystal-type accelerometers as the sensing elements. The calibrator provides a single-frequency (100 c/s), single-level (1 g) check on the operation of the General Radio vibration pickups used with General Radio vibration meters and with the Type 1560 Vibration Pickup System. The calibrator will vibrate, at a 1-g acceleration level, any pickup with a total mass of 300 grams or less, and can therefore be used to calibrate most of the popular accelerometers and vibration pickups in use today.

1.2 DESCRIPTION.

The Type 1557-A Vibration Calibrator is a small, battery-operated, self-energized shaker. A transistorized electromechanical oscillator is mounted in a cylindrical shaker by means of small leaf springs. The oscillator transmits motion to this shaker, which is in turn resiliently mounted in the vibration calibrator case. The mass of the shaker body is many times the mass of the oscillator, and the resonant frequency of the resilient mounting is much lower than the oscillator frequency. The amplitude of vibration of the shaker body is inversely proportional to the ratio of its mass to the mass of the oscillator.

A simplified wiring diagram of the calibrator is shown in Figure 2. With constant excitation, the amplitude of the electromechanical oscillator remains constant, while the amplitude of the shaker body varies as its mass is changed by the addition of the pickup to be calibrated. The indicatting meter is calibrated, therefore, in terms of pickup mass added to the shaker body. As the mass of the shaker is increased by the addition of a pickup, the amplitude of

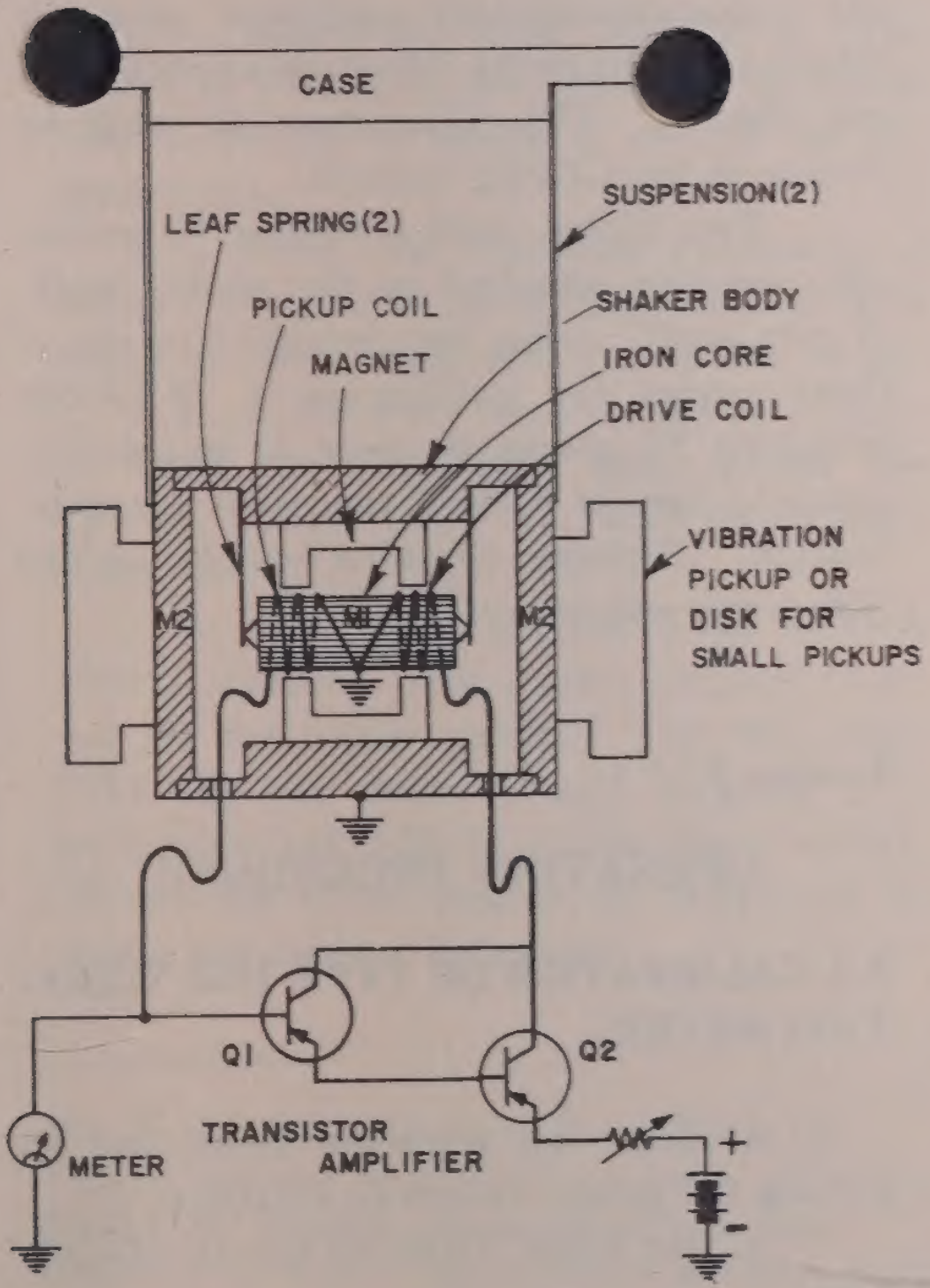

Figure 2. Elementary schematic diagram of Type 1557-A Vibration Calibrator.

the electromechanical oscillator must be adjusted to maintain constant amplitude of the shaker. This adjustment is made by means of the LEVEL control.

Two disks, each weighing 50 grams, are normally attached to the shaker body. A very small pickup may be taped to one of these disks for calibration. A pickup weighing 50 grams or more is mounted in place of one or both of the disks for calibration. Pickups weighing between 0 and 300 grams can be calibrated.

Section 2

OPERATING PROCEDURE

2.1 CALIBRATION OF TYPE 1553 VIBRATION METER.

a. Turn the vibration meter on by setting the power switch to 2-2000 c.

b. Set FUNCTION switch to ACCEL CAL.

c. Set SCALE SELECTOR switch to 3000.

d. Set METER READS switch to PK TO PK.

e. Attach the Type 1560-P51 or Type 1560-P52 Pickup to the Type 1557-A Vibration Calibrator in place of one of the 50-gram disks.

f. Place the vibration calibrator in either a vertical or horizontal position on a bench or other level space, and turn it on.

g. Allow a few seconds for the shaker to build up amplitude; then adjust the LEVEL control until the panel meter indicates 100.

h. The meter on the Type 1553-A should indicate 1090 inches/second^2 (1.0-1.2 on the lower scale).[1] On the Type 1553-AK, the meter should indicate 27.7 meters/second^2 (26-30 on the lower scale). Adjust the CAL control as necessary to obtain the correct indication.

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[1]For Type 1553-A, corresponding reading for:
VEL = 1.74 in./sec (1.6-1.9 on lower scale) with SCALE SELECTOR switch set to 3 in./sec.
DISP (20 C) = 2.77 mils (2.6-3.0 on lower scale) with the SCALE SELECTOR switch set to 3 mils.
For Type 1557-AK, corresponding reading for:
VEL = 0.0442 m/sec (43-45 on upper scale) with SCALE SELECTOR switch set to 0.1 m/sec.
DISP (20 C) = 0.0703 mm (65-75 on upper scale) with SCALE SELECTOR switch set to 0.1 mm.

2.2 CALIBRATION OF TYPE 761-A VIBRATION METER.

a. Turn on the vibration meter by pushing the METER READS ACCEL button. Set the METER SCALE switch to 100 k.

b. Remove both 50-gram disks from the Type 1557-A Calibrator and mount the Type 761-P1 Pickup in place of one. Be sure that the pickup cable is free and not restrained by nearby objects or bench.

c. Place the vibration calibrator in either a vertical or horizontal position on a bench top or some other level space, and turn it on.

d. After allowing a few seconds for the shaker to build up amplitude, adjust the LEVEL control until the panel meter indicates 215 (at the long line labeled "761-P1/759-P35"). The Type 761-A meter should indicate 1 g or 386 in./sec^2 (38.6 on the black or upper scale).[2] If it does not, set it there by means of the CAL screwdriver control located at the left of the input connector.

2.3 CALIBRATION OF TYPE 1560-P11 VIBRATION PICKUP SYSTEM USED WITH TYPE 1551 SOUND-LEVEL METER.

a. Connect the Type 1560-P51 or Type 1560-P52 Vibration Pickup to the Type 1560-P21 Control Box and the control box to the input of the Type 1551 Sound-Level Meter. Turn the sound-level meter on.

b. Set the Type 1560-P21 Control Box switch to ACCEL. On the sound-level meter, set the attenuator to 90 dB and the WEIGHTING switch to 20 kc.

c. Remove one of the 50-gram disks from the Type 1557-A Vibration Calibrator and mount the Type 1560-P51 or Type 1560-P52 Vibration Pickup in its place. Be sure the cable is free and unrestricted.

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[2]Corresponding readings for:
VELOCITY X 10 = 61.4 on black scale with METER SCALE switch at 100 k.
VELOCITY X 100 = 61.4 on black scale with METER SCALE switch at 10 k.
DISPLACEMENT X 1 = 97.8 on black scale with METER SCALE switch at 1 k.
DISPLACEMENT X 10 = 97.8 on black scale with METER SCALE switch at 100.

d. Place the vibration calibrator in either a vertical or horizontal position on a bench top or some other level space, and turn it on.

e. After allowing a few seconds for the shaker to build up amplitude, adjust the LEVEL control until the panel meter indicates 100. The Type 1551 meter should indicate +1.7 dB (i.e., the sound-pressure-level indication should be 91.7 dB[3]). If the meter does not indicate +1.7 dB, set it there by adjusting the CAL thumbset control.

2.4 CALIBRATION OF TYPE 1560-P11B VIBRATION PICKUP SYSTEM USED WITH TYPE 1551 SOUND-LEVEL METER.

a. Connect the Type 1560-P52 Vibration Pickup through the Type 1560-P21B Control Box to the input of the Type 1551 Sound-Level Meter. Turn the sound-level meter on.

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[3]Corresponding readings for Velocity: = 75.8 dB.
Displacement: = 49.8 dB.

b. Set the Type 1560-P21B Control [illegible] switch to ACCEL. On the [illegible]nd-level meter, set the attenuator to 100 dB and the WEIGHTING switch to 20 kc.

c. Remove one of the 50-gram disks from the Type 1557-A Vibration Calibrator and mount the Type 1560-P52 Vibration Pickup in its place. Be sure the cable is free and unrestricted.

d. Place the vibration calibrator in either a vertical or horizontal position on a bench top or some other level space, and turn it on.

e. After allowing a few seconds for the shaker to build up amplitude, adjust the LEVEL control until the panel meter indicates 100. The Type 1551 meter should indicate +1.7 dB (i.e., the sound-pressure-level indication should be 101.7 dB[4]). If the meter does not indicate +1.7 dB, set it there by adjusting the CAL thumbset control.

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[4]Corresponding readings for Velocity: = 85.8 dB.
Displacement: = 59.8 dB.

2.5 CALIBRATION OF TYPE 759-P35 VIBRATION PICKUP AND TYPE 759-P36 CONTROL BOX USED WITH TYPE 1551 SOUND-LEVEL METER.

a. Connect the Type 759-P35 Vibration Pickup to the Type 759-P36 Control Box, and connect the control box to the input of the sound-level meter. Turn the sound-level meter on.

b. Set the Type 759-P36 Control Box to ACCEL. On the sound-level meter, set the attenuator to 90 dB and the WEIGHTING switch to C.

c. Remove both 50-gram disks from the Type 1557-A Calibrator and mount the Type 759-P35 Vibration Pickup in place of one. Be sure that the pickup cable is free and unrestricted.

d. Place the Type 1557-A Vibration Calibrator in either a vertical or horizontal position on a bench top or some other level space, and turn it on.

e. After allowing a few seconds for the shaker to build up amplitude, adjust the LEVEL control until the panel meter indicates 215 (at the long line labeled "761-P1/

759-P36''). The meter on the Type 1551 uld indicate +1.7 dB (i.e. the sound-pressure-level indication sh d be 91.7 dB[5]). If the meter does not indicate 91.7 dB, set it there by adjusting the sound-level meter CAL control.

2.6 CALIBRATION OF OTHER VIBRATION PICKUPS.

The Type 1557-A Calibrator will subject any pickup mounted at either end of the shaker to a vibrating force of 1 g rms acceleration when the panel meter is set (by adjustment of the LEVEL control) to indicate the mass of the load added to the shaker body. This additional mass must be from 100 to 300 grams. Two 50-gram disks are normally attached to the shaker (one at each end). Short 1/4-28 studs on the ends of the shaker fit corresponding tapped holes in the disks. A pickup weighing 50 to 250 grams can replace one disk, and a pickup weighing 100 to 300 grams can be mounted in place of both 50-gram disks for calibration.

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[5]Corresponding readings for Velocity: = 85.8 dB.
Displacement: = 59.8 dB.

Double-faced, pressure-sensitive film or tape[6] can be used to attach a small pickup or accelerometer to the shaker disk. If one is repeatedly checking a particular type of pickup, it is suggested that one of the shaker disks be tapped to accept the mounting stud or screws for that pickup.

The calibration procedure is as follows: Mount the pickup on the vibration calibrator, turn the calibrator on, and allow a few seconds for the shaker to build up to a full amplitude. Adjust the LEVEL control so the panel meter indicates the load added to the shaker (i.e., pickup mass plus mass of any 50-gram disks in place). Read the output voltage from the pickup on a voltmeter, sound-level meter, or vibration meter. The shaker output is 1 g rms at 100 c/s.

2.7 CALIBRATION OF TYPE 1560-P13 VIBRATION PICKUP SYSTEM USED WITH TYPE 1551 SOUND-LEVEL METER.

a. Connect the Type 1560-P53 Vibration Pickup through the Type 1560-P23

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[6]Angiers Adhesive Division of Interchemical Co. or Scotch Brand, Minnesota Mining & Manufacturing Co.

Control Box to the input of the Type 1551 Sound-Level Meter. Turn on the sound-level meter.

b. Set the Type 1560-P23 Control Box to ACCEL. Set the attenuator on the sound-level meter to 90 dB and the WEIGHTING switch to 20 kc.

c. Mount the Type 1560-P53 Vibration Pickup on one of the 50-gram disks on the Type 1557-A Vibration Calibrator by means of double-sided tape. Its cable must be free and unrestricted.

d. Place the vibration calibrator in either a vertical or horizontal position on a bench top or other level surface and turn it on.

e. After allowing a few seconds for the shaker amplitude to build up, adjust the LEVEL control until the panel meter indicates 134. The Type 1551 meter should indicate +1.7 dB (i.e., the sound-pressure-level indication should be 91.7 dB[7]).

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[7]Corresponding readings for Velocity = 85.8 dB.
Displacement = 59.8 dB.

2.8 CALIBRATION OF TYPE 1560-P14 VIBRATION PICKUP SYSTEM USED WITH TYPE 1551 SOUND-LEVEL METER.

a. Connect the Type 1560-P54 Vibration Pickup through the Type 1560-P24 Control Box to the input of the Type 1551 Sound-Level Meter. Turn on the sound-level meter.

b. Set the Type 1560-P24 Control Box switch to ACCEL. Set the attenuator on the sound-level meter to 120 dB and the WEIGHTING switch to 20 kc.

c. Remove one of the 50-gram disks from the Type 1557-A Vibration Calibrator and mount the Type 1560-P54 Pickup in its place. Its cable must be free and unrestricted.

d. Place the vibration calibrator in either a vertical or horizontal position on a bench top or other level surface and turn it on.

e. After allowing a few seconds for the shaker amplitude to build up, adjust the LEVEL control until the panel meter indicates 130. The Type 1551 Sound-Level Meter should indicate +1.7 dB (i.e., the sound-pressure-level indication should be 121.7 dB[8]).

2.[illegible]CALIBRATION OF VIBRATION-MEASU[illegible]G SYSTEMS USED TO D[illegible]RMINE VIBRATION LEVELS IN dB.

Recent vibration specifications require vibration levels expressed in dB. For acceleration measurements, acceleration level, L_a, is used. Similarly, velocity level, L_v, and displacement level, L_d, are used. Proposed ASA standard reference levels for these quantities are:

$L_a = 10^{-5}$ m/s^2 (10^{-3} cm/s^2)

$L_v = 10^{-8}$ m/s (10^{-6} cm/s)

$L_d = 10^{-10}$ m (10^{-8} cm)

The Type 1557-A develops a standard vibration of 1 g at 100 c/s. For the above references, instruments calibrated with the Type 1557-A should read:

Acceleration level (1 g = 9.8 m/s^2),
$L_a = 119.8$ dB re 10^{-5} m/s^2

Velocity level (1 g = 0.0156 m/s at 100 c/s),
$L_v = 123.9$ dB re 10^{-8} m/s

Displacement level (1 g = 2.49×10^{-5} m at 100 c/s), $L_d = 107.9$ dB re 10^{-10} m.

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[8]Corresponding reading for Velocity = 105.8 dB
Displacement = 79.8 dB

Section 3

SERVICE AND MAINTENANCE

3.1 WARRANTY.

We warrant that each new instrument sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, sales engineering office, or authorized repair agency personnel, will be repaired, or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

3.2 SERVICE.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties

occur, our service engineers will assist any way possible. If the difficulty cannot be eliminated by the use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest sales engineering office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

3.3 CALIBRATION CHECK.

If the calibrator indicates that the sensitivity of a pickup or vibration meter has changed greatly, cross-check the calibrator on another pickup or meter. If the second vibration-measuring system seems to have changed in the same direction by the same amount, return the Type 1557-A

Vibration Calibrator to the General Radio Service Department for verification of calibration.

3.4 BATTERIES.

Four 1.3-volt mercury batteries power the Type 1557-A. A set of these batteries should operate for at least 100 hours.

One 6-volt dry battery powers the Type 1557-AS1. One battery should operate for at least 30 hours.

To check the battery, turn the OFF-BAT switch to BAT and observe the meter reading. The reading should be greater than 100 (marked B on the meter). The calibrator may work if the reading is less than 100, but operation will probably be unstable.

To gain access to the batteries, unscrew the knurled cap marked NEG BAT from the front panel. When storing the calibrator for a long period, remove the batteries and store them separately.

3.5 OPENING THE INSTRUMENT.

All components except the shaker body are attached to the front-panel assembly. To remove the assembly from the case,

remove four screws from the aluminum trim strip, grasp the knobs, and lift the assembly out of the case.

When returning the assembly to its case, always be careful that the wires connecting the shaker body to the amplifier board are placed so they will not rub against the side of the case or interfere in any way with the motion of the shaker body.

3.6 TEST VOLTAGES AND RESISTANCES.

Table 1 lists dc voltages and resistances at transistor terminals and anchor terminals. Turn the instrument on, set the

TABLE 1

TRANSISTOR (TYPE)	PIN OR A.T. NO.	DC VOLTS	OHMS TO GND	DC MA	AC VOLTS
Q1 (2N1374)	1	0.32	27		
	4	1.9			
	5	2.05	170k		
Q2 (2N1374)	1	0.32	27		
	4	2 0	150k		
	5	1.9			
ANCHOR TERMINAL	2	0	0		
	5	0.32	27	10 7	0.83
	6	0	160	0	1.03
	7	2.2	170k		

LEVEL control for a meter reading of 100 and attaching disks. Measure the voltages to ground with a vacuum-tube voltmeter.

Measure the resistances to ground with the instrument turned off and the transistors removed from the circuit.

Currents are given in Table 1 at anchor terminals #5 and #6. To measure the current, remove the clip lead from the anchor terminal and connect the milliammeter between the lead and the terminal. Both disks should be in place, the instrument should be on, and the LEVEL control set so the meter indicates 100.

For location of components and anchor terminals on the etched board, see Figure 3.

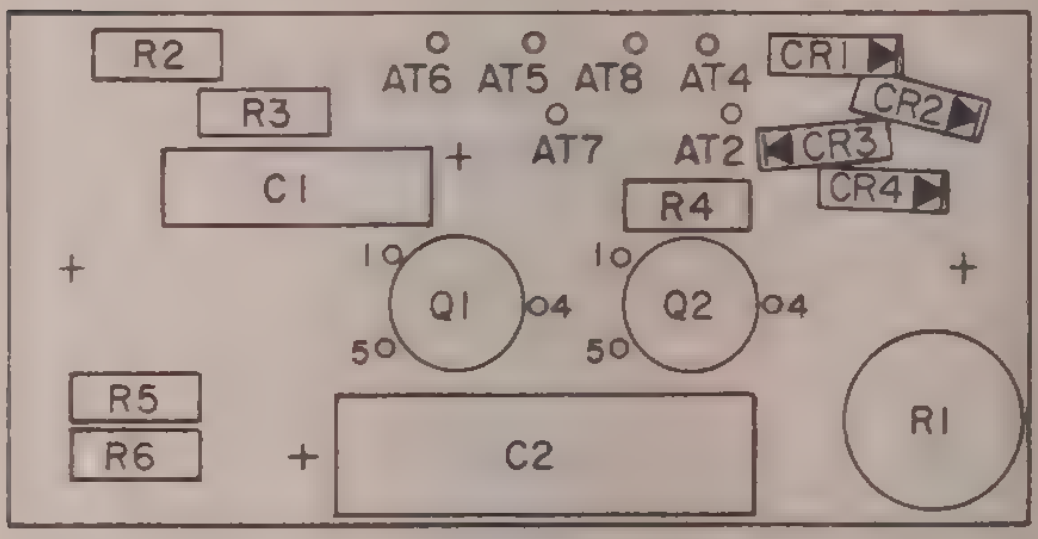

Figure 3. Location of components and terminals on etched board.

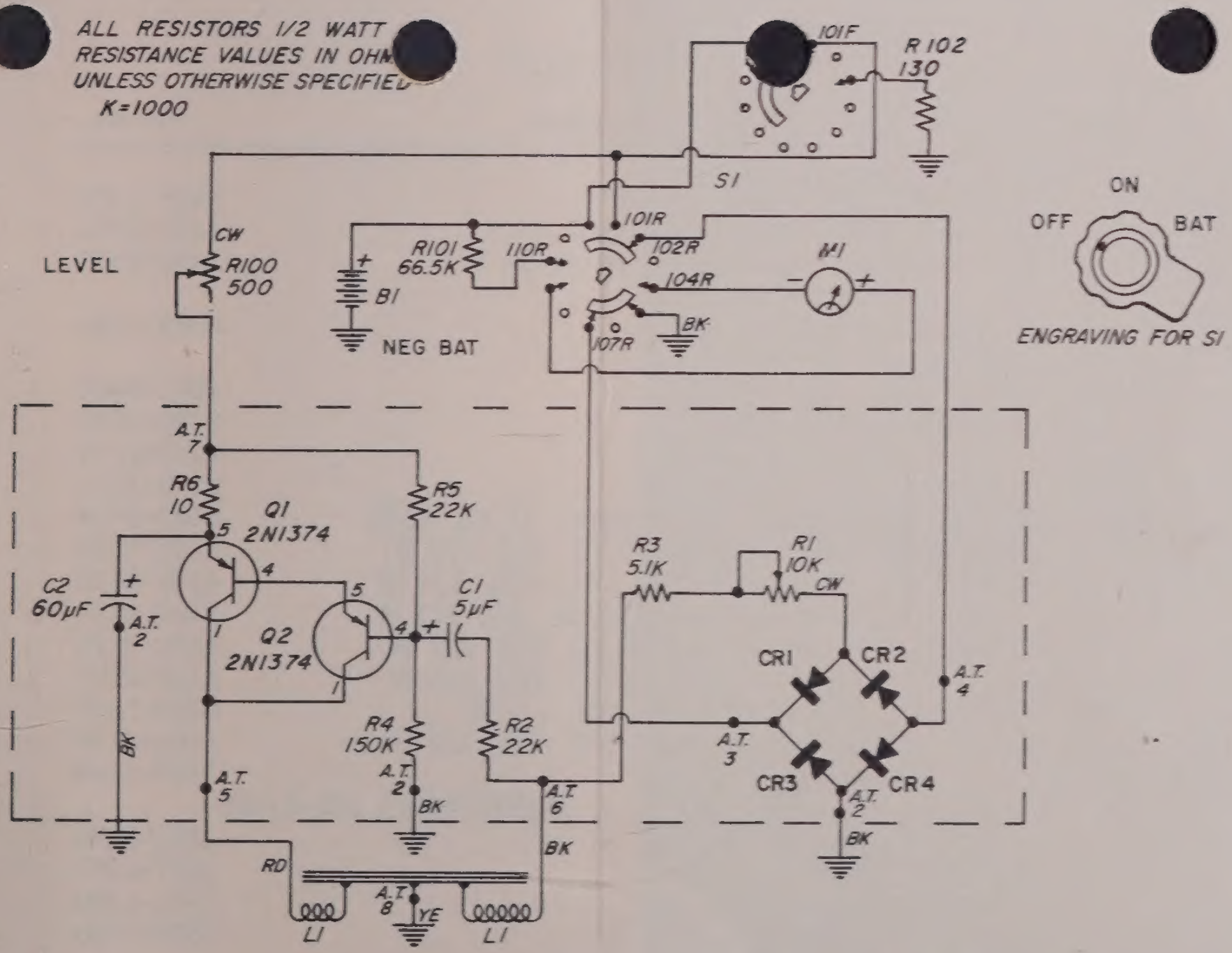

Figure 4. Schematic diagram for Type 1557-A Vibration Calibrator.

PARTS LIST

Ref No.	Description	Part No.
B1	BATTERY, (four used) 1.35 V	8410-1372
C1	CAPACITOR, Electrolytic, 5 μF 50 V	4450-3900
C2	CAPACITOR, Electrolytic, 60 μF 25 V	4450-2900
CR1 through CR4	DIODES, 1N34A	6082-1003
L1	COIL, Oscillator,	1557-2000
M1	METER, 100 μa dc	5730-0900
Q1	TRANSISTOR, 2N1374	8210-1374
Q2	TRANSISTOR, 2N1374	8210-1374
R1	POTENTIOMETER, Composition, 10 kΩ ±20%	6040-0700
R2	RESISTOR, Composition, 22 kΩ ±5% 1/2 W	6100-3225
R3	RESISTOR, Composition, 5.1 kΩ ±5% 1/2 W	6100-2515
R4	RESISTOR, Composition, 150 kΩ ±5% 1/2 W	6100-4155
R5	RESISTOR, Composition, 22 kΩ ±5% 1/2 W	6100-3225
R6	RESISTOR, Composition, 10 kΩ ±5% 1/2 W	6100-0105
R101	RESISTOR, Film, 66.5 kΩ ±1% 1/2 W	6350-2665
R102	RESISTOR, Composition, 130 Ω ±5% 1/2 W	6100-1135
S1	SWITCH, Rotary	7890-1880
	METER CASE HONEYWELL ME-3-701	
	BATTERY CAP	1557-6090
	KNURLED DISC	1557-6070
	KNOB (OFF-ON)	1501-1120
	KNOB (LEVEL)	5540-3000

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